

HabEx Study and Report Status

Keith Warfield

HabEx Study Office Manager
Jet Propulsion Laboratory, California Institute of Technology

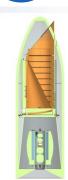
August 3, 2017

Key Accomplishments

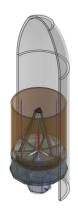


- Completed the design of the telescope, starshade, and coronagraph for the 4m baseline
- Completed the Team X spin stabilized starshade study.
- Participated in the ExEP technology gap assessment exercise
 - Only concept without a TRL 2 gap
 - 4m mirror assessed as TRL 4 due to use of micro-thrusters
- Submitted the Habex technology O2 delivery on June 30
- Submitted the 4m architecture to Aerospace CATE team for assessment of technical weaknesses and design concerns
 - Response is due the week of Sept 11
- Received input from JPL's National Security Program Office on a 4m segmented telescope design for starshade use only. NSPO telescope will be used as the notional on-axis design in our alternative starshade-only architectures
- Added an documentarian/editor to the team for the Interim Report
- Submitted 13 papers and posters on the HabEx design for next week's SPIE conference in San Diego





	Starshade	Coronagraph	Technology Gap	ExEP TRL Assessment at P&L	Our Assessment at Final Report
			Petal Shape stability	3	3
			Petal Position Accuracy	3	3
			LOWFS and control	3	4
			Starshade Starlight Suppression	3	4
			Starshade Edge Scattering	3	4
Enabling			Micro-Thrusters	3	5
ш			Coating Uniformity on Large Optics	4	4
			Coronagraph Architecture	4	4
			Large Aperture Primary	4	4
			Formation Flying	4	4
			Deformable Mirrors	5	5
			Visible Detectors	5	5
Enhancing			NIR Detectors	3	4 or 5



Remaining Work Needed for Interim Report



- Settle on the DRM
- Constrain the micro-thruster stabilization performance
- Team X UVS design session scheduled for 1st week of October
- Complete the starshade camera mechanical design
- Develop the schedule and cost estimates for the concept
- Develop the Science Trace Matrix and finalize the error budgets
- Put together Interim Report inputs for a mock CATE
- UTAS visit on the week of August 21

SLS



- SLS is moving forward in development
 - No reduction in funding for core rocket
 - Launch site in development
- 12 planned missions from 2019-2033
- First launch was scheduled for FY18 but delayed until FY19
 - Lightfoot to make an announcement on specifics about the delay this month

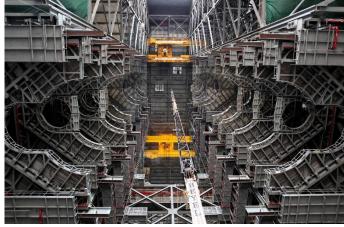








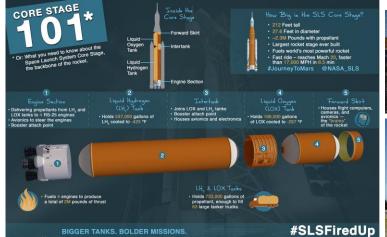








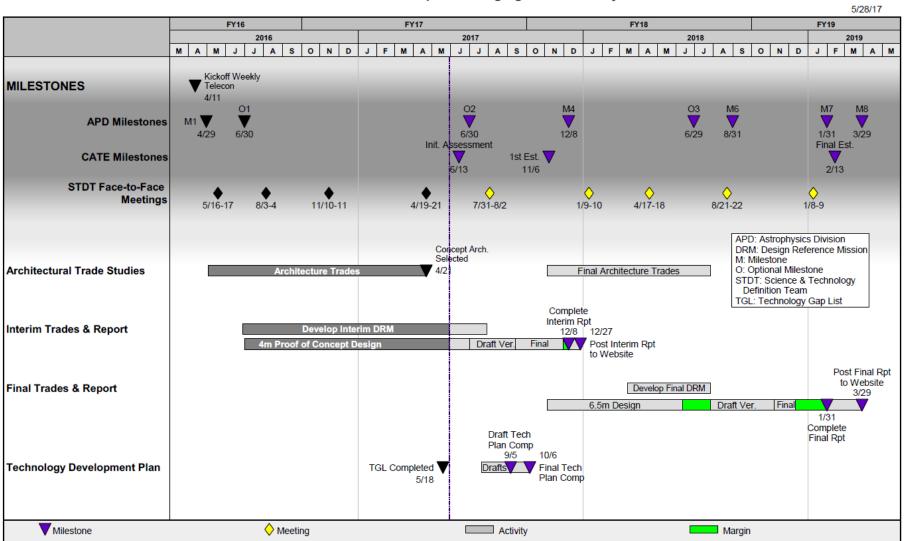




Detailed Schedule to IR Delivery



HabEx: Habitable Exoplanet Imaging Mission Study



Report Status Sheet 1/2



		1st Draft			
		F2F Review	Lead organizer (section)	Secondary	
Section #	Topic	8/1/17	and authors (subsections)	authors	Comments
Jestion	Fact Sheet	0/1/17	una adenora (sabacettoria)	uutiiois	Commence
1	1 331 511 51	Done	Scott		
2	Executive Summary	Donc	Scott		
3	Introduction		Scott	Sara	
4	Direct Imaging and Characterization of Exoplanets		Sara	Scott	
4.1	Getting to Know Our Nearest Neighbors		Sara	Maggie	
4.2	Characterizing the Diversity of Exoplanets		Ty	Shawn/Sara	
4.3	Searching for Habitable Conditions and Evidence of Habitability		Shawn	Ty/Sara	
4.4	Auxiliary Observational Requirements		Leslie	Bertrand/Sara	
4.4.1	How do we measure the mass?		Scott	Bertrand/Peter	
4.4.2	How do we measure the radius, albedo, and temperature?		Ту	?	
4.4.3	How do we measure the orbit?		Olivier	Kerri	
5	Direct Imaging and Characterization of Circumstellar Disks (Should this be 4.4?)		Karl	?	
6	General Astrophysics		Dan	Paul	
6.1	Local Value of the Hubble Constant		Dan		
6.1.1	Science question				
6.1.2	Measurement/observation				
6.1.3	Observation requirements				
6.2	The Escape Fraction		Paul		
6.2.1	Science question				
6.2.2	Measurement/observation				
6.2.3	Observation requirements:				
6.3	Tracing the Life Cycle of Baryons		Paul		
6.3.1	Science question				
6.3.2	Measurement/observation				
6.3.3	Observation requirements:				
6.4	Understanding the Impact of Massive Stars		Paul		
6.4.1	Science question				
6.4.2	Measurement/observation				
6.4.3	Observation requirements				
6.5	Measuring the star formation histories of nearby galaxies with stellar archaeology		Rachel		
6.5.1	Science question				
6.5.2	Observation				
6.5.3	Observation requirements				
6.6	Probing the nature of dark matter with dwarf galaxies		Rachel		
6.6.1	Science question				
6.6.2	Observation				
6.7	Solar System Applications		John		
6.7.1	Science question				
6.7.2	Observation				
6.7.3	Observation requirements				

Report Status Sheet 2/2



			1		1
		1st Draft			
		F2F Review	Lead organizer (section)	Secondary	
Section #	Торіс	8/1/17	and authors (subsections)	authors	Comments
7	The HabEx 4m Architecture Design	-,-,	Keith/Gary		
7.2	Mission Design		Farah/Rashied/Gary		
7.3	Payload Overview		Stefan		
7.3.1	Payload Overview Payload System/Optical Design		Stefan		
7.3.2	Telescope (thermal, mech)		Phil		
1.3.2	Telescope (itermal, mean) Telescope isolation/pointing control		Oscar/Phil		
	telescope isolation/pointing control		Phil		
7.3.3	telescope thermal control Starshade Camera		Stefan		
1.3.3	Starshade Gamera				
704	Starshade		Dave W/Steve W		
7.3.4	Coronagraph		Stefan		
7.3.5	UV Spectrometer		Stefan		
7.4	Telescope Bus		Farah/Rashied		
7.5	Starshade Bus		Farah/Rashied/Steve W		
7.6	System Integration		Farah/Rashied		
7.7	Operations		Farah/Rashied		
7.8	Development Schedule		Keith/Milana		
7.9	Mission Cost		Keith/Milana/Steve W		
7.10	Required Technology Development		Keith		
8	Alternate HabEx 4m Mission Architectures				
8.1	The 4m Mission Architecture Options and Trade		Keith		
8.2	The Minimum 4m Option: Starshade without a Coronagraph		Gary/Dave R		
8.2.1	Concept Overview and Key Performance Requirements		Gary/Dave R		
8.2.2	Payload Differences from Baseline Option		Gary/Dave R		
8.2.2.1			Gary/Dave R		
8.2.2.2	Telescope Starshade Camera		Stefan		
8.2.2.3	UV Spectrometer		Stefan		
8.2.3	Other Differences from Baseline Ontion		Gary/Dave R		
8.2.4	Mission Cost Required Technology Development		Milana		
8.2.5	Required Technology Development		Keith		
8.3	The Minimum 4m Option: Coronagraph without a Starshade		Gary		
8.3.1	Concept Overview and Key Performance Requirements		Gary		
8.3.2	Payload Differences from Baseline Option		Gary		
8.3.2.1	Telescope		Gary		
8.3.2.2	Coronagraph Camera		Gary		
8.3.2.3	UV Spectrometer		Gary		
8.3.3	Other Differences from Baseline Option		Gary		
8.3.4	Mission Cost		Gary/Milana		
	Mission Cost Required Technology Development The Two Starshade 4 m Architecture				
8.3.5	Required Technology Development		Gary		
8.4	The Two Starshade 4 m Architecture Other Architectures		Keith/Milana N.A.		
8.5	Other Architectures The HabEx 6.5m Mission Architecture		Keith		
40			rhonda/chris stark	Bertrand	
10 11	Design Reference Mission and Science Yield Estimation (Does this belong here?)		Rhonda	Keith	
	Technological Challenges		Rnonda	Keith	
11.1	Baseline 4m Challenges		Charact (Charact NA)		
11.1.1	Starshade Petal Deployment Accuracy and Shape Stability		Stuart/Steve W		
11.1.2	Coronagraph Architecture		Dimitri		
11.2	Key 4m Baseline Technologies already at TRL5 or higher				
11.1.3	Large Mirror Coating		Bala		
11.2.1	Micro-thrusters		Oscar/Ziemer		
11.2.2	DMs		Dimitri/Rick		Dimitri/Rick
11.2.3	LOWFS		Dimitri/Fang		
11.2.4	Visible and IR Detectors		Shouleh		
11.2.5	Starshade Performance Modeling		Stuart/Steve W		
11.2.6	Starshade Edge Scatter Suppression		Stuart/Steve W		
11.2.7	Formation Flying		Dan Scharf/Oscar/Carl		
11.2.8	Laser Metrology		Joel		
11.2.9	Laser Metrology Large Mirror Fabrication		Phil		

Interim Report Writing Process



- Report Editor/Documentarian: Samantha Ozyildirim
 - Issued writing guidelines on style and document logistics
 - Is responsible for Report configuration management
 - Will lead/coordinate all editing of the document as we progress

Reviews

- The draft report will be reviewed by JPL, ExEP, and APD
- Currently the process will take a month; we are looking to restructure so the reviews run in parallel

Unlimited Release/ITAR

- The report will be released to the public so proprietary and ITAR sensitive materials will need to be removed
- JPL will send the report through the JPL Unlimited Release System for ITAR review
- Areas known to be ITAR restricted or otherwise sensitive may be compiled in appendices for use by CATE reviewers, then clean removal for the public version

Current document timeline:

August	 finalize first draft; identify any missing sections text, tables and graphics
September	 finalize second and third drafts; all text and graphics are inno "TBDs"; begin cover art
October	 end-to-end editing; fix inconsistent style; remove redundant information; fix the messaging; work on appendices and Executive Summary
November	 finalize text and chart editing; finalize cover art; add references; drafts sent out for review
December	 compile review changes; send to unlimited release; send final limited release version to HQ
January	- receive report version cleared for unlimited release; post Interim Report to NASA webpage

Work After the Interim Report



• 4m Option

- Finalize coronagraph architecture decision
- Pointing stability modeling
- Improve material on primary mirror and micro-thrusters with industry help
- Possibly better detail on the workhorse camera
- Possibly improved DRM

• 6.5m Option

- Settle the 6.5m architecture
 - Option identification and cost, risk and performance assessments will begin in FY18 with selection in January. Design work will run to July
- MSFC will oversee the telescope design. Will likely get help from GSFC and JPL NSPO for highheritage on-axis telescope options.
- Starshade may not require much more design work but we may choose the NGAS design for the
 6.5m option
- Create a 6.5m DRM
- Final Report Writing
- Deliver CATE Inputs